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PESTICIDE USE ON BARLEY IN MONTANA

1994

National Agricultural Impact Assessment Program

Special Project 93-EPIX-1-0135

A. Reeves Petroff and Gregory Johnson
Department of Entomology
Montana State University
Bozeman, MT

Forward

PESTICIDE USE ON BARLEY IN MONTANA, 1994

Table of Contents

Introduction -----	4
Pesticide Survey Methods -----	4
Survey Results -----	4
Total Acres Treated With Pesticides -----	4
Pesticide Usage Results By Type of Pesticide Used -----	5
Herbicides -----	5
Seed Treatments -----	5
Insecticides -----	5
Summary -----	5
Table 1: Types of Pesticides Used On Barley In Montana, 1994 ----	5
Table 2: Herbicide Use In Montana, 1994 -----	6
Table 3: Application Characteristics Of Herbicides Used on Barley - Montana, 1994 -----	8
Table 4: Seed Treatments (Fungicides) Used On Barley In Montana, 1994 -----	9
Table 5: Insecticides Used On Barley In Montana, 1994 -----	9
Appendix 1. Pesticide-Use Survey On Barley -----	10
Appendix 2. Characteristics of Herbicides Used On Barley In Montana, 1994 -----	16
Appendix 3. WSSA Herbicide Classification System -----	17

PESTICIDE USE ON BARLEY IN MONTANA, 1994

Pesticides play an important role in agriculture. They are needed to protect crops from insect attack, diseases and from weed competition. Without the availability of pesticides, the quantity and quality of crop production would be sacrificed leading to substantial economic losses for producers, consumers and the state.

The United States Department of Agriculture (USDA) established the National Agricultural Pesticide Impact Assessment Program (NAPIAP) in 1976 to promote informed regulatory decisions on registered pesticides. NAPIAP accomplishes this mission through the management and coordination of USDA and State activities to:

- develop and analyze information on pesticide use and pest management practices;
- determine impacts of pesticide regulations on agricultural productivity, the supply of agricultural products, and product price, and;
- to address pest control issues related to health and the environment.

A pesticide use survey is generally conducted by Extension personnel from each state to remove the guess work from estimating kinds and quantities of pesticide used for pest control in agricultural crops. Following this procedure, a pesticide use questionnaire was mailed to Montana barley producers in March, 1995 to solicit pesticide use information during the 1994 growing season. The information obtained by this survey will serve as a useful benchmark for evaluating future herbicide use patterns in barley.

PESTICIDE SURVEY METHODS

The pesticide usage survey (Appendix 1) was designed to survey farmers and ranchers regarding the use of herbicides, fungicide seed treatments and insecticides on barley acres in Montana in 1994. Emphasis was placed on acres and bushels treated with specific pesticides along with treatment rates and type of applications made: custom or self. The survey and a letter explaining the purpose of the survey were mailed in March of 1995 to 630 barley producers.

SURVEY RESULTS

Sixteen percent (101) of the 630 surveys were returned. Of these, 85 farms (84 %) reported using herbicides, 69 farms (68%) reported using fungicide/seed treatments and 9 farms (9%) reported using insecticides. Total land reported by the survey was 300,904 acres with the average being 2979.3 acres. Total barley acres reported by the survey was 32,547 acres (10.8% of total land) with the average being 322.3 acres.

Total Acres Treated With Pesticides

Approximately 1.2 million acres of barley were harvested in Montana in 1994. The survey reported approximately 33,508 acres of these acres as having received a pesticide treatment.

Table 1: Types of Pesticides Used On Barley In Montana, 1994.

Type of Pesticide	No. of farms reporting Use	Total acres treated (of acres reported in survey)	% of barley acres reported
Herbicide	85	31,501	96.8
Fungicide	69	120	68.0
Insecticide	9	1,887	9.0

Pesticide Usage Results By Type of Pesticide Used

Herbicides

Eighteen herbicides were used singly, in premixes or in tank mixes to control weeds in barley in 1994 (See Table 2.) The herbicide 2,4-D amine was the most widely used herbicide when used alone (10,935 acres) with Fargo 10G (triallate in granular form) following with 10,473 acres being treated. As part of a tank mix, the herbicide 2,4-D ester was applied to more acres (14,532) than any other reported herbicide. Next in quantity applied was herbicide Ally or metsulfuron, also used as part of a tank mix, to treat 12,185 acres. The herbicide combination of Banvel (dicamba) and 2,4-D ester, the most frequently applied tank mix, was applied to 5962 acres.

Most herbicide treatments were made by the growers themselves (42,741 acres) with 4899 acres being treated by custom ground applicators and 1632 acres being treated by custom aerial applicators (See Table 3.)

Seed Treatments - Fungicides

Seed treatments used by survey respondents during 1994 are summarized in Table 4. Vitavax (carboxin) was the most widely used seed treatment with the majority of producers preferring to treat their own seed. A total of 39,046 bushels of seed-treated barley was reported by the survey.

Insecticides

A total of seven farms reported insecticide use to barley in the survey. This represents 6.9% of all farms reporting. The survey reported a total of 1887 acres being treated with insecticides. Insecticide treatments also included seed treatments containing lindane for control of wireworms. See Table 5.

SUMMARY

Approximately 1.3 million acres in Montana were planted to barley in 1994 with 1.2 million acres being harvested for grain. From this survey it can be estimated that about 97% of these acres were sprayed with herbicides and 6% were sprayed with insecticides. The most widely used herbicide was 2,4-D which followed the general trend in the winter and spring wheats (Montana Agricultural Statistics, 1994.)

Table 2: Herbicide Use On Barley in Montana, 1994

Herbicide Name	Formulation	Rate (ai/acre)	# of Applications	Total Acres Treated	% total barley acres treated	Target Weed Species
Ally	60 DF	0.06 oz	1	450	1.4	FP,Th
Ally + 2,4-D Amine	60DF + 4EC	0.6 oz + 0.25 lb	3	2680	8.2	Ko,Mus,Th,RT,Tmus, WB
Ally + 2,4-D ester	60DF + LV6	0.6 oz + 0.25 lb	8	2344	7.2	Bl, Ko, Mus, RT Tmus,WB
Ally + Assert + 2,4-D ester	60DF + 2.5AS + LV6	0.6 oz + 0.7 lb + 0.25 lb	1	191	0.6	Bl, WO
Ally + Banvel	60DF + SGF	0.6 oz + 0.06-0.13 lb	1	2000	6.1	CC, Ko Mus, WB
Ally + Banvel+ 2,4-D Ester	60DF + SGF + LV6	0.06 oz + 0.06-0.13 lb + 0.25 lb	2	805	2.2	FB, Ko, Mus, RT,WB
Ally + Banvel + MCPA ester	60DF + SGF + 4EC	0.06 oz + 0.06-0.13 lb + 0.23-0.70 lb	1	1000	3.1	None listed
Ally + Bronate	60DF + 2+2	0.06 oz + 0.38-0.75 lb	1	400	1.2	Ko, Th
Ally + MCPA ester	60DF + 3.7E	0.06 oz + 0.23-0.69 Lb	5	1434	4.4	Bl, Ko, Mus, RT, TM Th, WB
Ally + Tordon + 2,4-D	60DF + 22K + 4E	0.06 oz. + 0.016-.023 lb. + 0.25 lb	2	1331	4.1	Ko, RT, WB
Amber + 2,4-D amine	75DF + 4EC	0.21 oz + 0.24-0.48 lb	1	160	0.5	Pw, TM
Amber + 2,4-D ester	75DF + LV6	0.21 oz + 0.24-0.95 lb	5	1602	4.9	Bl, Ko, Mus, Pw, RT, WB
Amber + Banvel +1 2,4-D ester	75DF + SGF + LV6	0.14-0.28 oz + 0.06-0.09 lb + 0.25-0.50 lb	2	555	1.7	Ko, Pw, RT, WB
Amber + MCPA ester	75DF + 3.7E	0.14-0.28 lb + 0.23-0.69 lb	1	300	0.9	Mus, WB
Amber + MCPA ester + Tordon	75DF + 4E + 22K	0.14-0.28 oz + 0.25 lb + 0.016-0.23 lb	1	314	1.0	Bl, Ko, WB
Assert	2.5AS	0.38-0.47 lb	4	1704	5.2	WO
Assert + Avenge	2.5AS	0.23 lb + 0.5 lb	1	330	1.0	WO
Assert + Express + MCPA ester	2.5AS + 75DF + 4EC	0.38-0.47 lb + 0.125-0.25 oz + 0.25-0.75 lb	1	542	1.7	Mus, Th, WO
Assert + MCPA ester	2.5AS + 4EC	0.38-0.47 lb + 0.25-0.75 lb	8	1431	4.4	Bl, GF, Mus, FP, TM, WO, WB
Assert + 2,4-D ester	2.5AS + LV6	0.38-0.47 lb + 0.25-1.0 lb	1	150	0.5	WO

Weed Key: Annuals=AnnBedstraw=Bs, Broadleaves= Bl, Canada Thistle CT, Cheatgrass=Cg, Cowcockle=Cc, Dandelion=Dl, Field Bindweed = Field Pennycress (Fanweed) = FP, Green Foxtail = GF, Kochia = Ko, Lambsquarters = Lq, Mustards = Mus, Pigweed = Pw, Quackgrass=Qg, Russian Thistle = RT, Shepard's Purse = SP, Sow Thistle= ST, Tansy Mustard= TM, Thistles = Th, Tumble Mustard = Tum, Vineweed = Vw, Volunteer Canola = VC, Volunteer Grains = VG, Waterpod, Wp, Buckwheat = WB, Wild Oats = WO, Yellow Mustard = YM.

Table 2: Herbicide Use On Barley in Montana, 1994 - Continued

Herbicide Name	Formulation			Total Acres Treated	% total barley acres treated	
Avenge	2AS	0.63-1.0 lb	1	40	0.1	WO
Avenge + Harmony Extra	2AS + 75DF	0.63-1.0 lb + 0.23-0.45 oz	1	100	0.3	Ko, WO
Banvel + 2,4-D amine	SGF + 4EC	0.06-.125 lb + 0.23-.375 lb	3	370	1.1	Bs, Ko, Lq, Mus, Pw, RT, TM, WB, YM
Banvel + 2,4-D ester	SGF + LV6	0.06-.125 lb + 0.23-.375 lb	9	5962	18.3	Bl, CT, FP, Ko, Mus, Pw, TM, WB
Banvel + MCPA ester	SGF + 4EC	0.06-.125 lb + 0.25-.375 lb	4	622	1.9	Ko, Mus, Pw, RT TM, WB
Bronate	2+2	0.25-0.5 lb	4	409	1.3	Bl, Ko, Lq, Mus, WB
Buctril	2EC	0.25-0.5 lb	1	300	0.9	Ko, RT
Curtail	2.38EC	0.60-0.75 lb	7	681	2.1	CT, DI, ST, Th
Express	75DF	0.13-0.25 oz	1	170	0.5	Ko, RT
Express + 2,4-D ester	75DF + LV6	0.13-0.25 oz + 0.125-.375 lb	1	320	1.0	Ko, Mus, Lq, Pw
Express + MCPA ester	75DF + LV6	0.13-0.25 oz + 0.125-.375 lb	1	211	0.6	CT
Fargo	4EC	1.25 lb	7	1858	5.7	WO
Fargo	10G	1.0-1.5 lb	19	10473	32.2	Cg, WO
Harmony Extra + 2,4-D ester	75DF + LV6	0.23-0.45 oz + 0.13-0.38 lb	1	91	0.3	Bl, Ko, Lq
Harmony Extra + Hoelon	75DF + 3EC	0.23-0.45 oz + 0.5-1.0 lb	1	15	<0.1	Bl, GF, WO
Harmony Extra + MCPA amine	75DF + 4EC	0.23-0.45 oz + 0.13-0.38 lb	1	82	0.3	FB, Ko, WB
Hoelon	3EC	0.75-1.0 lb	1	35	0.1	WO
MCPA ester	4EC	0.25-0.75 lb	6	2425	7.5	Ann, FB, Bl, CT, FP, Ko, Mus, SP, Th, WB
MCPA ester + Tordon	4EC + 22K	0.25-0.5 lb + 0.031-.047 lb	1	420	1.3	Cc, WB
Roundup	4EC	0.25-0.5 lb	11	1417	4.4	Bl, CT, Cg, FB, Qg, RT, VG, VC, WO
Roundup + 2,4-D amine	4 EC + 4 EC	0.38-0.5 lb + 0.5 lb	1	120	0.4	Qg, WO
Tordon	22K	0.016-.023 lb	1	75	0.2	WB
Tordon + 2,4-D ester	22K + LV6	0.016-.023 lb + 0.25-0.5 lb	2	500	1.5	Bl
Treflan	4EC	0.5 lb	1	150	0.5	WO
2,4-D amine	4EC	0.5-0.75 lb	9	1215	3.7	Bl, CT, FP, Ko, Mus, RT
2,4-D ester	LV6	0.25-1.0 lb	11	1438	4.4	FP, Ko, Lq, Mus, Pw, RT, TM, Tum, Vw, Wp, WB
TOTALS			158	49272		
% Barley Acres Total Barley Acres = 32547					151.4	

Table 3: Application Characteristics of Herbicides Used On Barley - Montana, 1994.

Trade Name	Acres Treated	Rate (ai/acre)	Total Product Used	Self applied acres - ground	Custom applied acres - ground	Custom applied acres - air
Ally	450	0.06 oz	27 oz (1.7 lb)	450	0	0
Ally in mixes	12185	0.06 oz	731.1 oz (45.7 lb)	11485	700	500
Amber in mixes	2931	0.14-0.28 oz	410.3 - 820.7 oz	2931	0	0
Assert	1704	0.38-0.47 oz	647.5 - 800.9 lb	1704	0	0
Assert in mixes	2644	0.38-0.47 oz	1004.7 - 1242.7 lb	2171	282	0
Avenge	40	0.63-1.0 lb	25.2 - 40 lb	0	40	0
Avenge in mixes	100	0.63-1.0 lb	63.0 - 100.0 lb	100	0	0
Banvel in mixes	10759	0.06-.125 lb	645.5 - 1344.9 lb	6124	1200	50
Bronate	409	0.25-0.5 lb	102.3 - 204.5 lb	339	70	0
Bronate in mixes	400	0.38-0.75 lb	152.0 - 300.0 lb	400	0	0
Buctril	300	0.25-0.5 lb	75.0 - 150.0 lb	300	0	0
Curtail	681	0.60-0.75 lb	408.6 - 510.8 lb	681	0	0
Express	170	0.13-0.25 oz	22.1 - 42.5 oz	170	0	0
Express in mixes	862	0.13-0.25 oz	112.06 - 215.5 oz	753	0	0
Fargo 4EC	1858	1.25 lb	2322.5 lb	685	1105	68
Fargo 10G	10473	1.0-1.5 lb	10473 - 15709.5 lb	9861	612	0
Harmony Extra	288	0.23-0.45 oz	66.2 - 129.6 oz	173	15	0
Hoelon	35	0.75-1.0 lb	26.3 - 35 lb	35		
Hoelon in mixes	15	0.5-1.0 lb	7.5 - 15 lb	0	15	0
MCPA amine in mixes	82	0.13-0.38 lb	10.7 - 31.2 lb	82	0	
MCPA ester	7965	0.23-0.70 lb	1832.0 - 5575.6 lb	4753	282	505
Roundup	1417	0.25-0.5 lb	354.3 - 708.5 lb	1352	65	0
Roundup in mixes	120	0.38-0.5	45.6 - 60 lb	120	0	0
Tordon	75	0.016-0.023 lb	1.2 - 1.7 lb	0	0	75
Tordon in mixes	2145	0.016-0.023 lb	34.3 - 49.3 lb	1645	0	0
Tordon in mixes	420	0.031-0.047 lb	13.0 - 19.8 lb	420	0	0
Treflan	150	0.5 lb	75.0 lb	150	0	0
2,4-D amine alone	10935	0.5-0.75 lb	5467.5 - 8201.25 lb	830	0	385
2,4-D amine in mixes	9430	0.23-0.5 lb	2168.9 - 4715.0 lb	3120	0	50
2,4-D ester alone	1438	0.25-1.0 lb	359.5 - 1438 lb	1114	0	324
2,4-D ester in mixes	14532	0.25 lb	3633 lb	11852	2660	0

Table 4: Seed Treatments (Fungicides) Used On Barley In Montana, 1994

Fungicide Used	No. Farms Reporting	Bushels Treated	% Total Bushels Treated	Commercial Pre-treated (bushels)	Self-treated (bushels)	Commercially Treated After Purchase (bu.)	Target Pests
Vitavax (carboxin)	37	14020	35.9	6067	6155	1798	Covered smut, Loose smut
Vitavax (carboxin) + Imazilil	16	6733	17.2	3703	865	2165	Covered smut, loose smut, barley leaf stripe, common root rot
Vitavax (carboxin) + Lindane	7	3650	9.3	1110	2250	290	Covered smut, loose smut, wireworms
Vitavax (carboxin) + Thiram + Lindane	2	1000	2.6	0	1000		Covered smut, loose smut, wireworms
Vitavax (carboxin) + Imazalil + Lindane	5	2536	6.5	546	440		Covered smut, loose smut, barley leaf stripe, common root rot, wireworms
Vitavax (carboxin) + Maneb + Lindane	1	170	0.4	60	110		Covered smut, loose smut, wireworms
Maneb	1	200	0.5	0	2000		Covered smut
Maneb + Lindane	10	6832	17.5	0	6832		Covered smut, wireworms
Maneb + Lindane + Imazilil	1	145	0.4	0	145		Barley leaf stripe, common root rot, covered smut, wireworms
Unusable data	6	3670	9.4	1825	1650	195	Not entered
TOTALS	86	39046	99.7	13311	19647	5998	

Table 5: Insecticides Used On Barley In Montana, 1994

Insecticide Used	Rate (Actual material per acre)	# Applications Made	Total Acres Treated	% of barley acres reported	Type of Treatment	Pests
Parathion 8E	0.5 pt	2	580	1.8	Self	Grasshoppers
Furadan 4F	0.25-0.5 pt	3	160	0.5	Self	Grasshoppers
Ambush 2E Pounce 3.2E	6.4-12.8 oz 4.0-8.0 oz	2	181	0.6	Self	Cutworms
Vitavax (carboxin) + Lindane	6.0 oz/100 lb. Seed	See Table 5	See Table 5	See Table 5	See Table 5	Wireworms
DB Green (maneb + lindane)	2 oz dust/bu. Seed 3 oz oz/bu. Seed	Seed Table 5	See Table 5	See Table 5	See Table 5	Wireworms

All applications made post-emergence to Crop

Appendix 1. Montana Pesticide-Use Survey On Barley



Department of Entomology

MSU Bozeman
Bozeman, MT 59717-0302
Phone: 406-994-3860
Fax: 406-994-6029

March 9, 1995

Dear Producer:

Enclosed is a survey designed to determine the types and amounts of pesticides used in barley production in Montana. It is to our benefit to accurately determine the importance of pesticides to this crop in order to estimate the effect on production if suspension or cancellation of a particular pesticide or pesticides occurs. The better we can document the need for a specific pesticide, the better our chances of retaining those that are necessary for agricultural production.

You have been selected as part of a representative sample of Montana farmers to complete this questionnaire. Based upon your response and that of other Montana producers, we will be able to accurately determine the importance of those pesticides that are registered on barley.

The few minutes you spend in completing this survey will contribute much to the overall effort. We greatly appreciate your willingness and are looking forward to receiving your completed questionnaire in the enclosed self-addressed, postage paid envelope. Please note: Any information you supply will be strictly confidential and used only to obtain state averages and totals.

Sincerely,

Greg Johnson
Entomologist

Jack Riesselman
Plant Pathologist

Pete Fay
Weed Specialist

enclosure:

Appendix 1. Montana Pesticide-Use Survey On Barley - continued

MONTANA PESTICIDE USE SURVEY ON BARLEY

All land in this farm (including land rented from others) Acres _____.

All barley in this farm (including land rented from others) Acres _____.

1994 BARLEY ACREAGE TREATED WITH PESTICIDES

Acres treated with		
Fungicides (not including seed treatments)	Herbicides	Insecticides

SEED TREATMENTS

Disease	Fungicide	Bushels of Seed Purchased as Pre-treated	Bushels of Seed Commercially Treated After Purchase

COMMON DISEASES

Barley Stripe
Common Root Rot
Covered Smut
Loose Smut

COMMONLY USED FUNGICIDES

Vitavax (carboxin)
Imazalil (imazalil)
Maneb (maneb)
AGSCO DB Green (Maneb + lindane)
Granol (maneb + lindane)
Flo Pro IMZ (imazalil)
Double R (imazalil)
Nu-zone (imazalil)
PCNB (quintozene)

Appendix 1. Montana Pesticide-Use Survey On Barley - continued

FUNGICIDES

Disease	Fungicide	Amount Used Per Acre	Acres Treated	Applied By		Application Method	
		pt qt lb		s)self c)custom Circle one		g) ground a) aerial Circle one	
				s	c	g	a
				s	c	g	a
				s	c	g	a
				s	c	g	a
				s	c	g	a
				s	c	g	a
				s	c	g	a
				s	c	g	a
				s	c	g	a

COMMON DISEASES

Barley Scald

Barley Net Blotch

COMMONLY USED FUNGICIDES

Maneb 80 (maneb)

Tilt (proiconazole)

Appendix 1. Montana Pesticide-Use Survey On Barley - continued

HERBICIDES

Herbicide	Formulation	Amount of Formulation Used Per Acre	Acres Treated	Weed Species Treated	Applied By s)self c)custom Circle one	Application Method g) ground a) aerial Circle one
					s c	g a
					s c	g a
					s c	g a
					s c	g a
					s c	g a
					s c	g a
					s c	g a
					s c	g a
					s c	g a
					s c	g a

COMMONLY USED HERBICIDES

Ally ((60DF) (metsulfuron)
 Amber (75DF) (triasulfuron)
 Assert (2.5AS) (imazamethabenz)
 Avenge (2AS) (difenzoquat)
 Bronate 2 Plus 2 (bromoxynil + MCPA)
 Buckle (10G) (triallate and trifluralin)
 Buctril (2EC) (bromoxynil)
 Curtail (M (2.35 EC) (clopyralid + 2,4-D)
 Curtail (2.38 EC) (clopyralid + 2,4-D)
 Express (75 DF) (tribenuron methyl)
 Fargo (4 EC) (triallate)
 Fargo (10G) (triallate)
 Glean (75 DF) (chlorsulfuron)

Harmony Extra (75 DF) (thifensulfuron
 + tribenuron)
 HiDep (3.8EC) (mixed acid 2,4-D)
 Hoelon (3 EC) (diclofop methyl)
 Landmaster BW (glyphosate + 2,4-D)
 MCPA amine (4 EC) (MCP)
 MCPA ester (4EC) (MCP)
 Roundup RT (4EC) (glyphosate)
 Roundup (4 EC) (glyphosate)
 Stinger (3EC) (clopyralid)
 Tordon 22K (picloram)
 2,4-D amine (4EC) (2,4-D)
 2,4-D ester (LV6) (2,4-D)

Appendix 1. Montana Pesticide-Use Survey On Barley - continued

INSECTICIDES

Insects Controlled	Insecticide Trade Name	Formulation Used	Amount of Formulation Used Per Acre pt qt lb	Acres Treated	Applied by s) self c) custom	Application Method g) ground a) aerial	Time of Application 1) At Planting 2) Pre-emergence 3) At cultivation 4) Post-emergence

COMMON INSECT PESTS

Armyworms and Cutworms
 Barley Thrips
 Cereal leaf beetle
 Grasshoppers
 Russian Wheat Aphid
 Wireworms

Furadan 4F (carbofuran)
 Lannate L, LV, 90 (methomyl)
 Lindane G, 25 EC (lindane)
 Malathion 57% EL, 5 EC, 95% Spray
 Methyl Parathion 4E, 6E (methyl parathion)
 Parathion 8E (ethyl parathion)
 PennCap 2FM (methyl parathion)
 Pounce 3.2 EC, 25 WP (permithrin)
 Semaspore Bait (Nosema locustae protozoa)
 Sevin Baits (carbaryl), e.g. De-Bug-1 Bait 2%
 Carbaryl
 Thiodan 3 EC, 50 WP (endosulfan)

COMMONLY USED INSECTICIDES

Ambush 2E, 25WP (permithrin)
 Biobit, Dipel (Bacillus thuriengiensis bacteria)
 Di-syston 8E (disulfoton)
 Di-syston 15G (disulfoton)

Appendix 1. Montana Pesticide-Use Survey On Barley - continued

COMMENTS

Please include your comments, if you have any, on the following items:

1. What is the impact from cancellation of key pesticides (fungicides, herbicides, insecticides) on your business or operation?

2. Are the pesticides you are using providing you effective, economical control?

3. Do you have other concerns relative to pesticides, e.g., availability, registration, laws governing use, recordkeeping, etc?

Thank you for your cooperation.

Appendix 2. Characteristics of Herbicides Used On Barley - Montana, 1994.

Trade Name	Common Name	Chemical Family	WSSA Classification	Mode of Action	Manufacturer
Ally	Metsulfuron	Sulfonylurea	2	Amino Acid Inhibitor	Dupont
Amber	Triasulfuron	Sulfonylurea	2	Amino Acid Inhibitor	Ciba
Assert	Imazamethabenz	Imidazolinone	2	Amino Acid Inhibitor	American Cyanamid
Avenge	Difenzoquat	Bipyridylum	8	Cell Membrane Disruptor	American Cyanamid
Banvel	Dicamba	Benzoic Acid	4	Synthetic Auxin Inhibitor	BASF
Bronate	Bromoxynil + MCPA	Benzonitrile See MCPA	6 4	Photosystem II See MCPA	Rhone-Poulenc
Buctril	Bromoxynil	Benzonitrile	6	Photosynthetic Inhibitor	Rhone-Poulenc
Curtail	Clopyralid	Pyridines	4	Growth Regulator	Dow Elanco
Express	Tribenuron	Sulfonylurea	2	Amino Acid Inhibitor	Dupont
Fargo	Triallate	Thiocarbamate	8	Shoot Inhibitor	Monsanto
Harmony Extra	Thifensulfuron + Tribenuron	Sulfonylurea Sulfonylurea	2	Amino Acid Inhibitor	Dupont
Hoelon	Diclofop	Aryloxyphenoxy-propionates	1	Lipid Synthesis Inhibitor	AgrEvo USA
MCPA amine MCPA ester	MCPA amine	Phenoxy-carboxylic acid	4	Growth Regulator	Various
Roundup	Glyphosate	Amino acid derivative	9	Amino Acid Inhibitor	Monsanto
Tordon	Picloram	Pyridine	4	Growth Regulator	Dow Elanco
Treflan	Trifluralin	Dinitroaniline	3	Seedling Growth Inhibitor	Dow Elanco
2,4-D Amine 2,4-E Ester	2,4-D amine 2,4-D Ester	Phenoxy-Carboxylic Acid	4	Growth Regulator	Various

Appendix 3. Weed Science Society of America (WSSA) Herbicide Classification System

Group	Primary Site of Action
1	Inhibitors of acetyl CoA carboxylase (ACCase)
2	Inhibitors of acetolactate synthase (ALS)
3	Microtubule assembly inhibitors
4	Synthetic auxin inhibitors
5	Inhibition of photosystem II
6	Inhibition of photosystem II - same site, different binding behavior
7	Inhibition of photosystem II - same site, different binding behavior
8 (Thiocarbamates)	Inhibition of lipid synthesis - not ACCase inhibition
(Avenge)	Unknown
9	Inhibition of EPSP synthase
14	Inhibition of protoporphyrinogen oxidase (PPO)
22	Photosystem I - electron diversion

